Final Symposium of the research project

SeeOff – Strategieentwicklung zum effizienten Rückbau von Offshore-Windparks

Development of efficient strategies for offshore wind farm decommissioning

March 30th 2022

SeeOff - Strategieentwicklung zum effizienten Rückbau von Offshore Windparks

(Development of strategies for sustainable offshore wind farm decommissioning)

Project duration:

November 2018 – April 2022

Projekt coordination:

City University of Applied Sciences Bremen

Prof. Dr.-Ing. Silke Eckardt

Website:

www.seeoff.de

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HSB

Nehlsen

Deutsche Windtechnik

STIFTUNG OFFSHORE WINDENERGIE

EnBW

VATTENFALL

TenneT

09.00	Welcome and introduction (Prof. Dr.-Ing. Silke Eckardt, City University of Applied Sciences Bremen)
09.20	Dismantling of offshore wind farms at sea (Bernd Köhler, Deutsche Windtechnik)
09.40	Comminution of offshore wind farm components and recovery of materials at land (Dr. Sven Rausch, Nehlsen AG)
10.00	Q & A Session
10.20	*Coffee Break and Networking in Lounge-Area*
10.35	Economic efficiency of offshore wind farm decommissioning (Janina Bösche, City University of Applied Sciences Bremen)
10.50	Environmental impacts of offshore wind farm decommissioning (Vanessa Spielmann, City University of Applied Sciences Bremen)
11.10	Occupational safety of offshore wind farm decommissioning (Mandy Ebojie, City University of Applied Sciences Bremen)
11.25	Q & A Session
11.45	*Lunch Break and Networking in virtual Lounge-Area*
12.15	Bringing economic efficiency, environmental impacts and occupational safety together: Multi criteria decision making for offshore wind farm decommissioning (Vanessa Spielmann, City University of Applied Sciences Bremen)
12.30	Public acceptance of offshore wind farm decommissioning (Philipp Tremer, German Offshore Wind Energy Foundation)
12.45	Q & A Session
13.05	*Goodbye and subsequent Networking in Lounge-Area*
13.45	Closing of conference platform

Final Symposium of the research project *SeeOff*, March 30th 2022

Environmental impacts of offshore wind farm decommissioning

Vanessa Spielmann
City University of Applied Sciences Bremen

HSB
Hochschule Bremen
City University of Applied Sciences

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Strategieentwicklung zum effizienten Rückbau von Offshore-Windparks

Objectives for sustainable offshore wind farm decommissioning

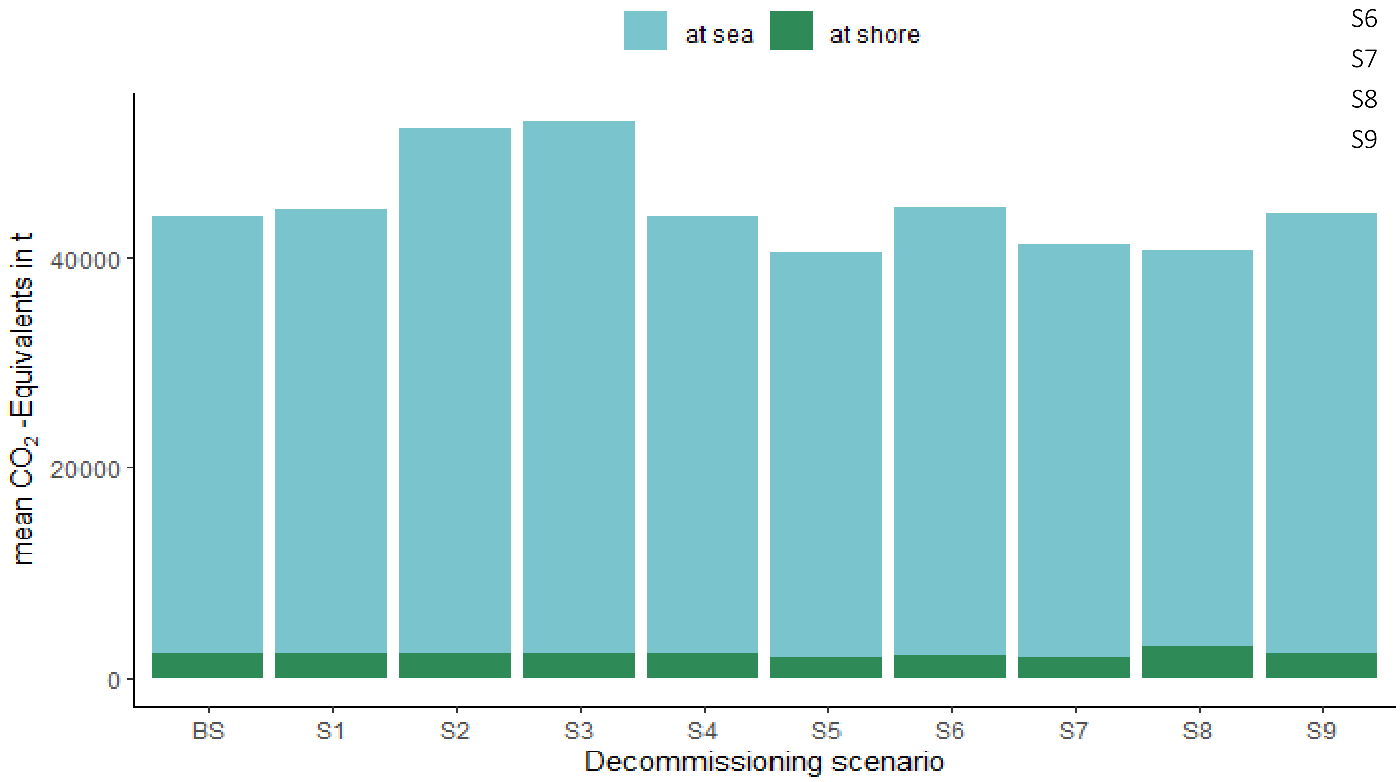
Sustainable decommissioning of offshore wind farms					
Category	**Economy**	**Environment**			**Health and safety**
Aspect	Economic efficiency	GHG-Emission	Biodiversity	Resource efficiency	Safety at work
Objective	Economic efficient	Low GHG-Emission	Minor local impact	High resource efficiency	Few hazards
Attribute	(Present) value of costs/ decommis-sioned MW	CO_2-Equivalent	Fraction of species richness maintained	Recovery rate	Hazard measure

Environmental impacts
GHG Emissions

- GHG emissions are measured in t CO_2-Equivalents
- CO_2-Equivalents are calculated based on the fuel consumptions of the resources required for the decommissioning activities
  - At sea: vessels for dismantling and transport
  - At land: machinery at harbour, transport and recovery plants

Fuel Type	Conversion factors			Reference
	CO_2	CH_4	N_2O	
Marine Gas Oil	3205.99 kg/t	0.82 kg/t	43.27 kg/t	(UK Government Department for Business, Energy & Industrial Strategy 2019)
Diesel	2.641735 kg/l	0.000004 kg/l	0.000143 kg/l	Calculated based on (UBA 2021)
German electricity mix	0.408000 kg/kWh	0.000183 kg/kWh	0.000373 kg/kWh	(Juhrich 2021)

Environmental impacts
GHG Emissions



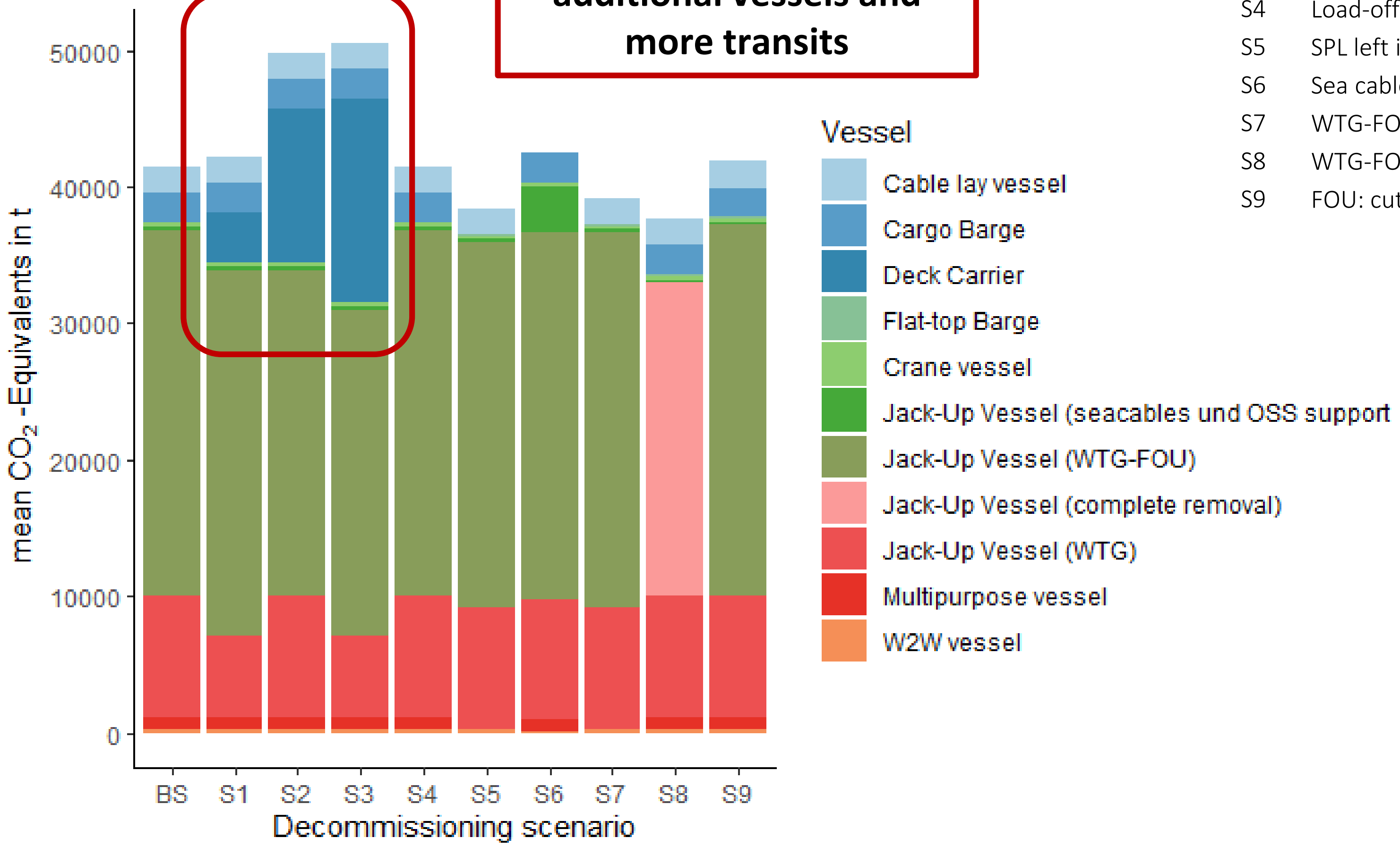
Decommissioning scenarios

BS	Baseline scenario
S1	Feeder concept WTG
S2	Feeder concept WTG-FOU
S3	Feeder concept WTG and WTG-FOU
S4	Load-off OSS with SPMT
S5	SPL left in situ
S6	Sea cables left in situ
S7	WTG-FOU: cut above seabed
S8	WTG-FOU: complete removal
S9	FOU: cut with diamond wire machine

Environmental impacts

GHG Emissions

Feeder concepts require additional vessels and more transits



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Environmental impacts
GHG Emissions

Conclusion

Main driver of GHG emissions are vessels.

More vessels and more transits increase GHG emissions.

→ Innovative dismantling and logistic concepts that

- forego or at least reduce the utilisation of large vessels
- utilise alternative fuels

Environmental impacts
Resource efficiency

Calculation of recovery rate based on recovery rate of construction and demolition waste (2011/753/EU):

$$\text{Recovery rate of construction and demolition waste, in \%} = \frac{\text{Materially recovered amount of construction and demolition waste}}{\text{Total amount of generated construction and demolition waste}}$$

Only construction and demolition waste brought ashore is considered

Assumption: all materials and components are disposed → no reuse

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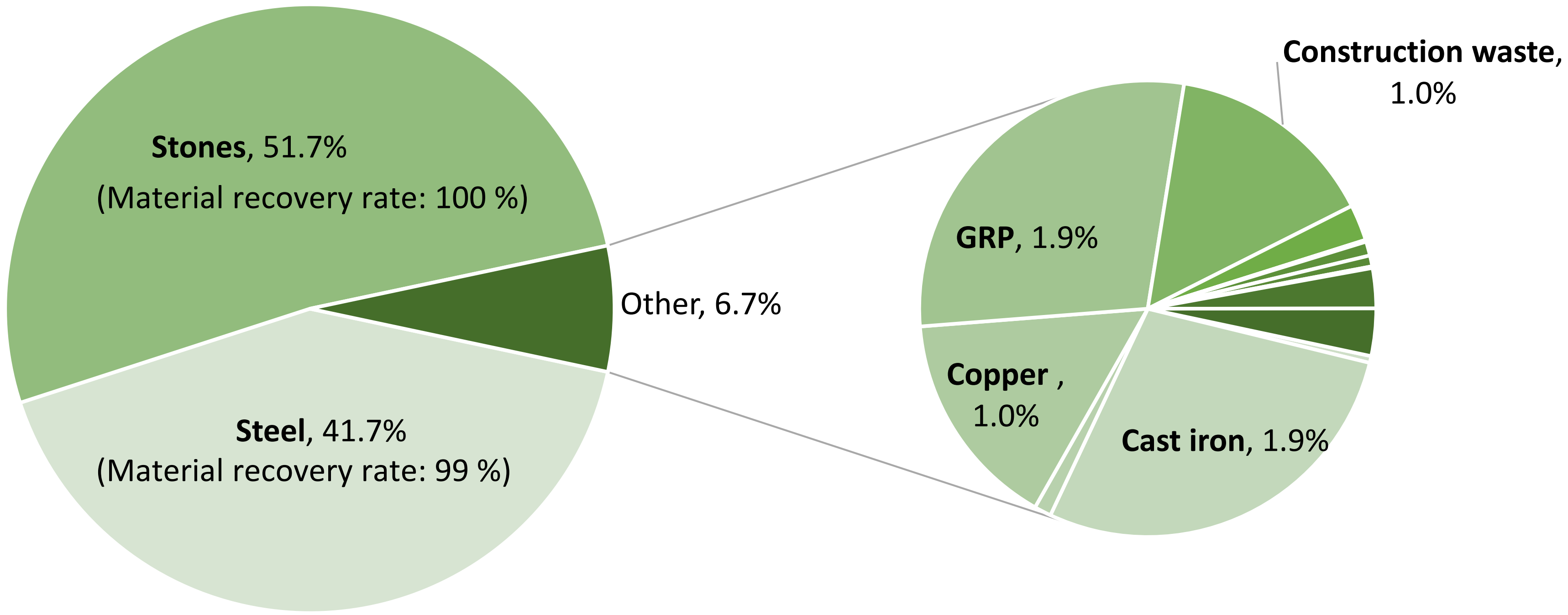
Environmental impacts
Resource efficiency

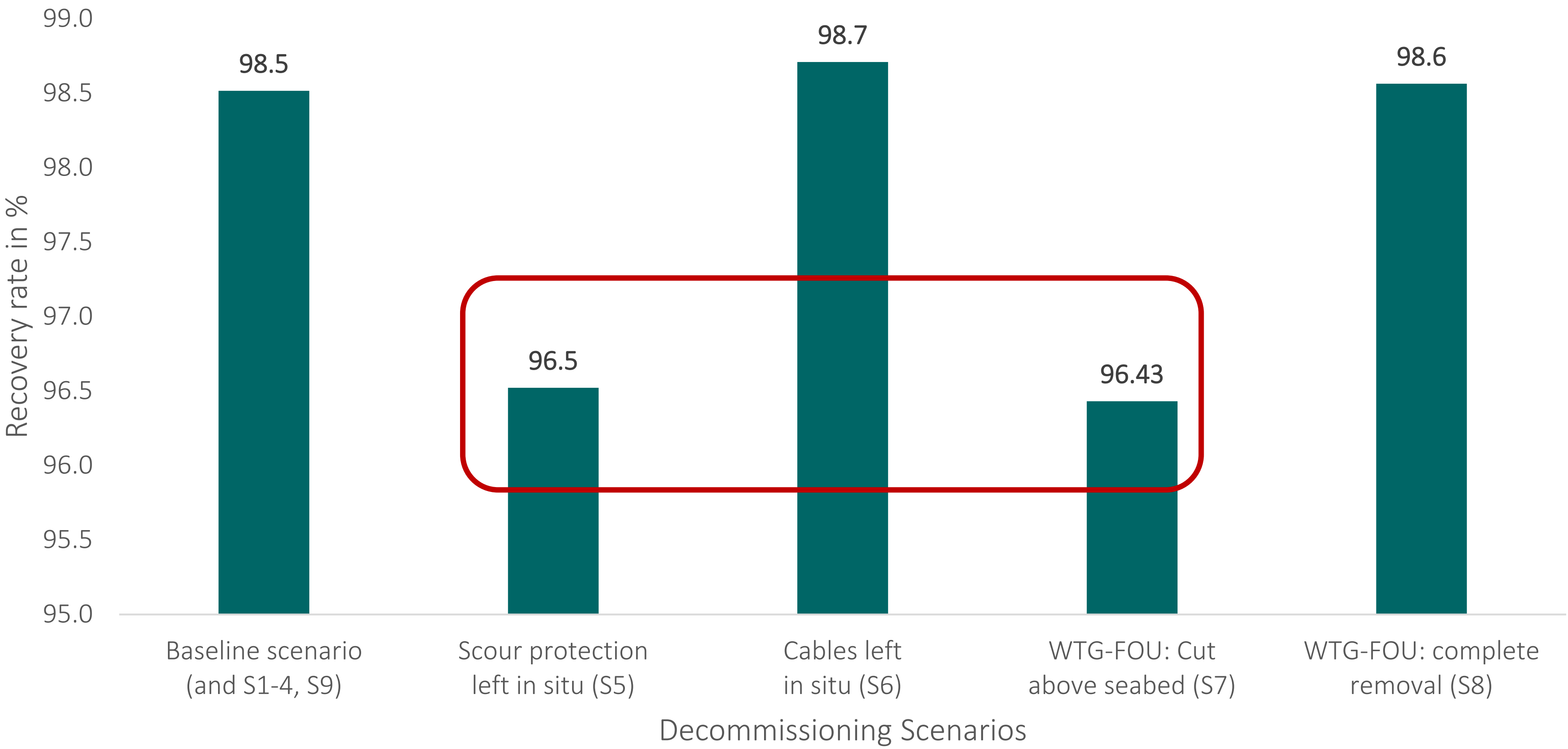
- Mass balance of reference offshore wind farm
- Overall mass: 226 366 t



- All other materials < 1 %

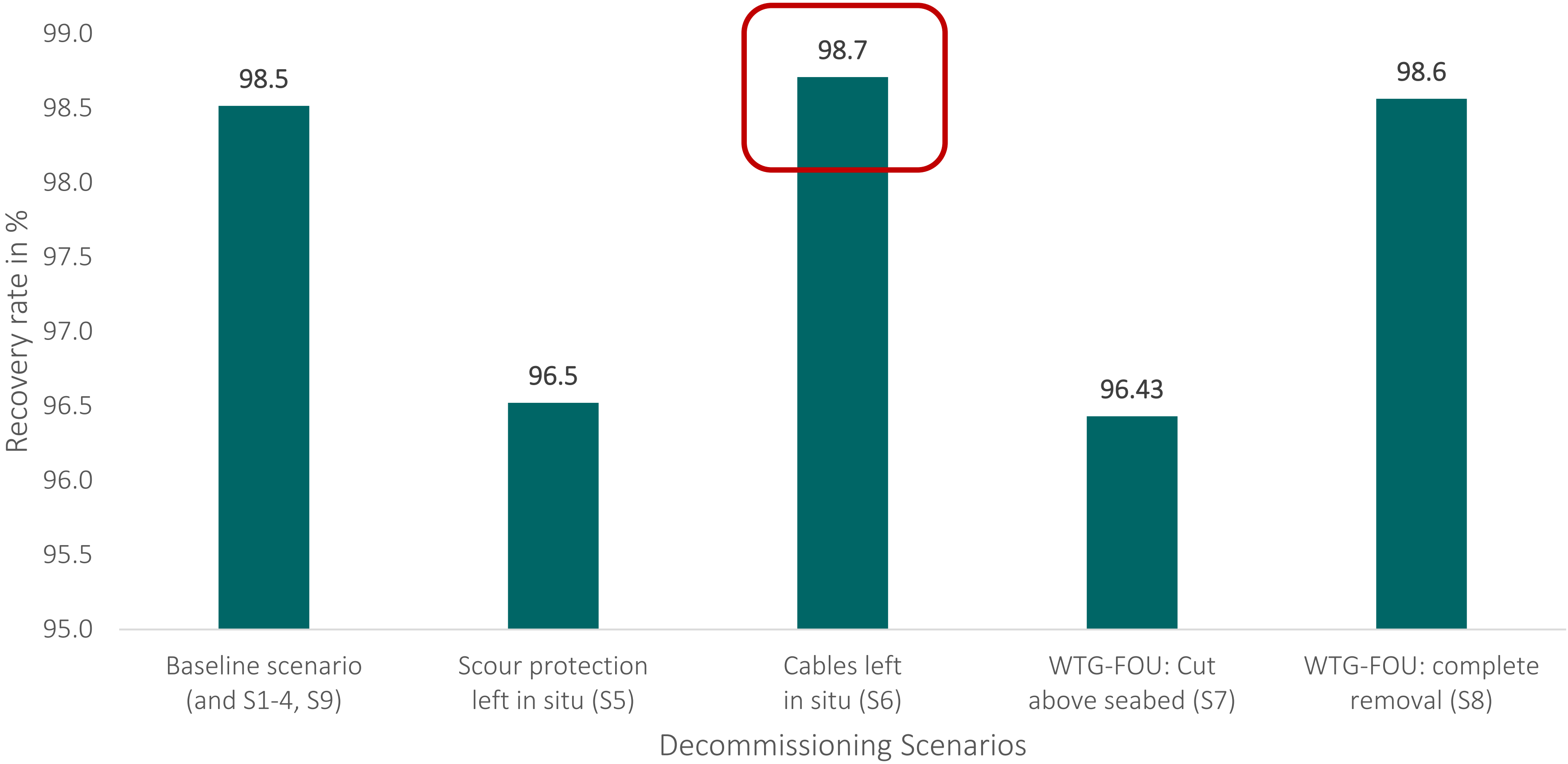
Environmental impacts
Resource efficiency

Recovery rate decrease, if waste with high material recovery rates are left in situ (stones and steel)



Environmental impacts
Resource efficiency

Recovery rates increases slightly, if components consisting of materials with lower material recovery rates are left in situ (sea cables)



Environmental impacts
Resource efficiency

Conclusion

Recovery rates of all decommissioning scenarios are high (> 96%)

Recovery rate is a common and widely applied attribute in the circular economy.

→ In order to compare different scopes of OWF decommissioning other attributes accounting for types and amount of materials that remain at sea and are not recycled should be considered.

Environmental impacts

Biodiversity

Aim: Investigation of the impacts of different scopes of decommissioning on the benthic species richness at the scour protection layer and the foundation structure close to the seabed.

Challenge: The StUK4 usually only requires monitoring of growth up to a depth of 10 m and the fifth year of operation.

Solution: subset of the CRITTERBASE of the Alfred-Wegener-Institute contains data of 16 European offshore projects.

Project	Country	Year commissioned	Type	Number of locations monitored	Max. Sampling depth
BelWind	Belgium	2009	Foundation (Monopiles)	2	15 m
			Scour protection	2	30 m
C-Power	Belgium	2008-2011	Foundation (Gravity-base)	2	30 m
			Scour protection	2	30 m
Fino	Germany	2003	Foundation (Jacket)	1	30 m
Princess Amalia	Netherlands	2006-2007	Foundation (Monopiles)	4	17 m
			Scour protection	4	24.5 m

Environmental impacts
Biodiversity

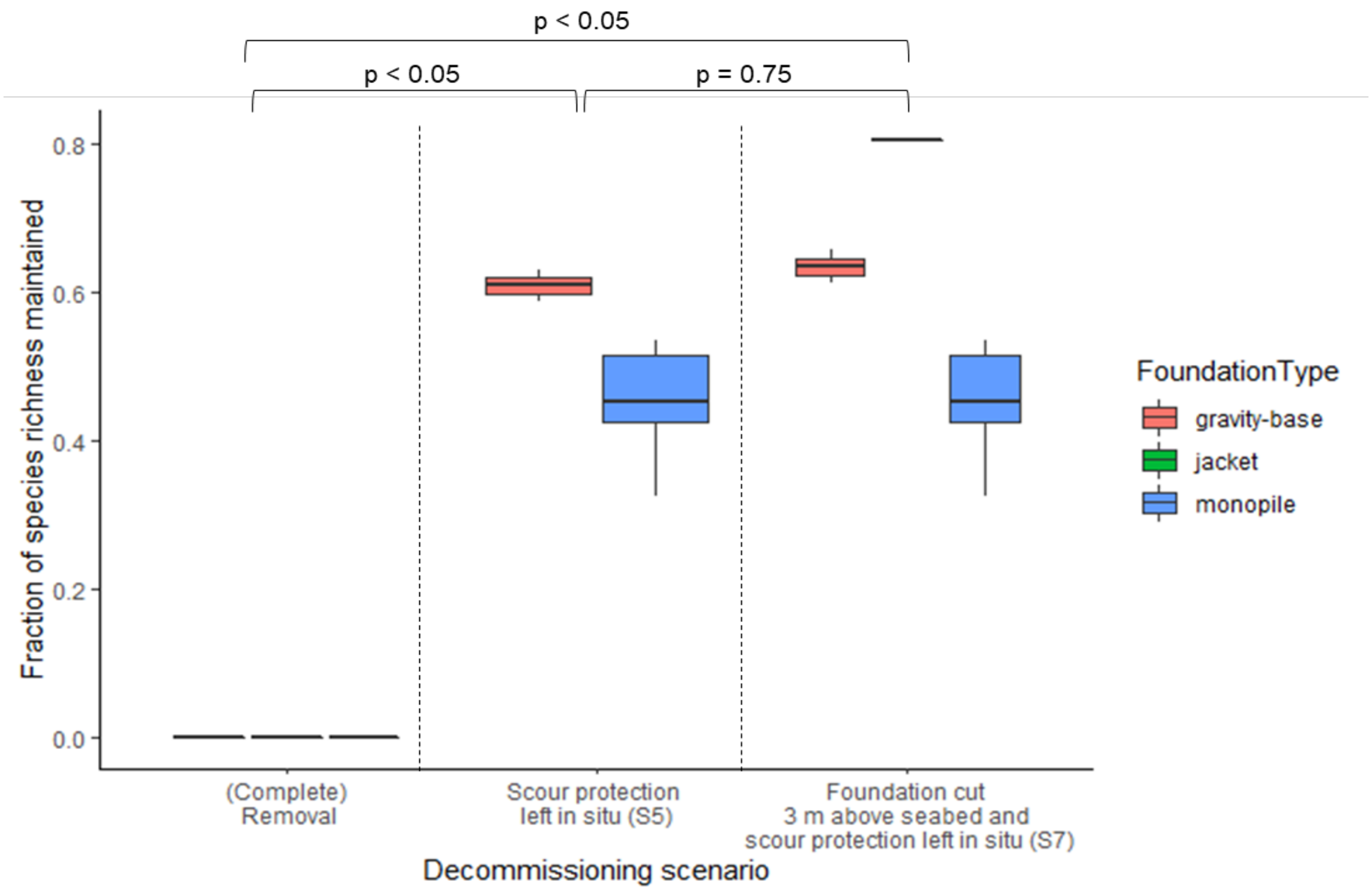
Calculation of the ***fraction of species richness maintained*** (sets number of species e.g. on the scour protection, in relation to the number of species at the entire location).

Investigation of how partial decommissioning scenarios influence fraction of species richness maintained by Kruskal-Wallis and subsequent post hoc test (dunn test).

Decommissioning scenarios:

- Leave scour protection layer in situ (S5)
- Leave scour protection layer in situ and cut MP 3 m above seabed (S6)

Environmental impacts
Biodiversity



Environmental impacts
Biodiversity

Conclusion

Our analysis show that partial decommissioning scenarios, particularly leaving scour protection in situ, benefit hard-substrate associated benthic species.

However, the data base is not sufficient, to make well-founded statement about the decommissioning scenarios on benthic community

→ Systematic and long-term surveys including scour protection and the bottom of the foundation structures are required.

→ In order to assess impacts of partial decommissioning on the soft-bottom communities, according surveys are needed as well.

Thank you for your attention!

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